Atmospheric Forcing and the Structure and Evolution of the Upper Ocean in the Bay of Bengal

J. Thomas Farrar and Robert A. Weller
Woods Hole Oceanographic Institution
266 Woods Hole Rd.
Clark 212A (MS# 29)
Woods Hole, MA 02543-1050
phone: (508) 289-2691 fax: (508) 457-2163 email: jfarrar@whoi.edu

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LONG-TERM GOALS

Our long-term goals are to improve understanding and simulation of physical processes in the upper ocean that influence air-sea interaction and the upper-ocean environment. The focus of this project is an investigation of the processes that determine the vertical structure and evolution of the upper ocean in the southern Bay of Bengal. The Bay of Bengal is an interesting region from the perspective of air-sea interaction: the presence of a salinity-stratified barrier layer is believed to have important effects on the SST field and the regional atmosphere because the shallow stratification favors a relatively rapid response of the upper ocean to surface forcing. The strong, shallow stratification in the region and the dynamical processes governing the upper-ocean structure and air-sea interaction have not yet been adequately characterized and understood, posing a challenge to the ability of numerical models to simulate and predict changes in the ocean and atmosphere there. With this project, we seek to use new and existing measurements to test, scrutinize, and improve the conceptual, theoretical, and dynamical constructs of air-sea interaction in the Bay of Bengal.

OBJECTIVES

The present effort involves inter-related observational components:

(1) Analysis of new and historical field observations and satellite data to improve understanding of air-sea interaction and upper-ocean dynamics in the presence of the barrier layer. As a part of this effort, the PIs have been participating in planning meetings and meetings geared at strengthening ties with international partners, including scientists and officials from Sri Lanka and India.

(2) Participation in research cruises to perform high-resolution (2-km horizontal, 1-m vertical) sampling of upper-ocean structure using an Underway CTD (UCTD).

(3) Deployment of a short-term surface mooring for ~50 days during the intensive operating period of the campaign to provide a detailed view of the forcing and evolution of the complex upper-ocean stratification in the region. The mooring will carry instrumentation for high-quality estimates of surface fluxes and high-resolution vertical profiles of temperature, salinity, and velocity over the upper 100 m. The mooring will be able to carry instruments for other investigators. A novel aspect of the proposed mooring is that, as a cost-saving measure, the mooring would be

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constructed from used parts that are normally discarded. The short duration of the deployment and the presence of a US research vessel in the region during the deployment will mitigate the risk and potential impact of a mooring failure.

APPROACH

Work to date and that planned for the near future uses an "Underway CTD" instrument (manufactured by Oceanscience of Carlsbad, CA) to measure vertical profiles of temperature and conductivity (salinity) from a moving vessel. The UCTD system (Figure 1) consists of a 2-kg instrument and a small electric winch; spectra line is wound on the instruments tailspool, and the winch is allowed to freespool, so that the instrument can be dropped from the stern of the ship and fall directly downward at a constant speed while the ship is underway. For temperature/salinity profiles of the upper 400 m of the ocean, casts can be repeated about every 15 minutes, giving a horizontal resolution of about 3.7 km at a ship speed of 8 knots. The horizontal resolution can be increased or decreased by varying the ship speed.

Our research group will participate in two cruise legs planned for the Bay of Bengal during November/December 2013, with three people on each leg to lead 24-hour UCTD operations. This is unusually heavy usage for these UCTD systems, and we will send two complete UCTD systems to ensure against mechanical failures. Cruise participants from India and Sri Lanka, and other available cruise participants, will be trained to stand watch and assist in UCTD operations.

Later during this project (anticipated for FY2015), we plan to deploy a heavily instrumented air-sea interaction mooring to collect measurements of the air-sea exchange of heat, momentum, and freshwater and the coincident evolution of the upper ocean. Depending on the needs of the larger DRI and the measurements planned by Indian colleagues, we may carry out a short-term deployment (~50 days) as originally proposed, or we may do a longer deployment of up to one year.

WORK COMPLETED

Work on this project began in April 2013. Our primary focus has been on gearing up for fieldwork scheduled for November-December 2013 aboard the RV *Roger Revelle*; our Underway CTD measurements will provide a key data set on the spatial variability of temperature and salinity in the Bay of Bengal, with fine vertical (~1 m) and horizontal (2-10 km) resolution. All gear and instruments are now in transit to Sri Lanka, where it will be loaded on the ship. We have also participated in meetings to build partnerships with colleagues from Indai and Sri Lanka and in meetings to plan and refine the overall measurement program for the ASIRI DRI. As a part of the planning effort, we have begun analysis of available in situ and satellite data to refine our hypotheses about the role of the shallow upper-ocean stratification in air-sea interaction in the region.

RESULTS

As most of our work to date has been focused on preparing for the upcoming fieldwork, we do not have any significant results to report.

IMPACT/APPLICATIONS

The data to be collected this fall will provide a new and detailed view of the spatial variability of the upper ocean in the Bay of Bengal; these data will improve understanding of the space-time variability of the upper ocean in the Bay and will help to refine and focus ONR field campaigns in the region planned for the coming years.

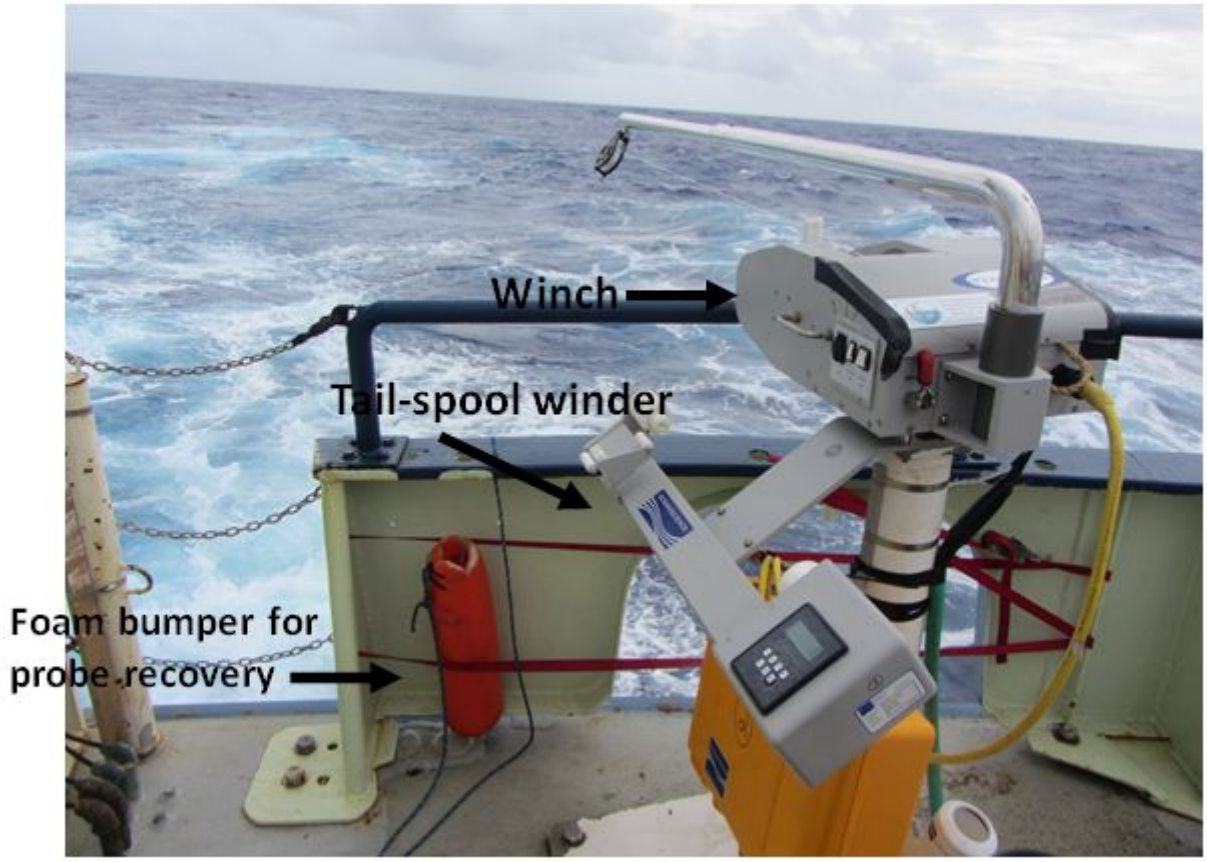

Figure 1: UCTD system during deployment on the port side of the Knorr's fantail.

RELATED PROJECTS

This project is closely related to the DURIP award, "An Air-Sea Interaction Buoy/Mooring System for Study of Air-Sea Interaction in the Open Ocean" (N00014-13-1-0685; PIs Robert A. Weller and J. Thomas Farrar). We intend to employ the buoy being constructed under that award to collect measurements of air-sea fluxes and upper-ocean evolution in the Bay of Bengal for this project.

This project is closely related to several other projects operating under the ASIRI DRI. There is close interaction on scientific goals, hypotheses, and measurements, as well as coordination on logistical matters, such as container shipments to Sri Lanka.